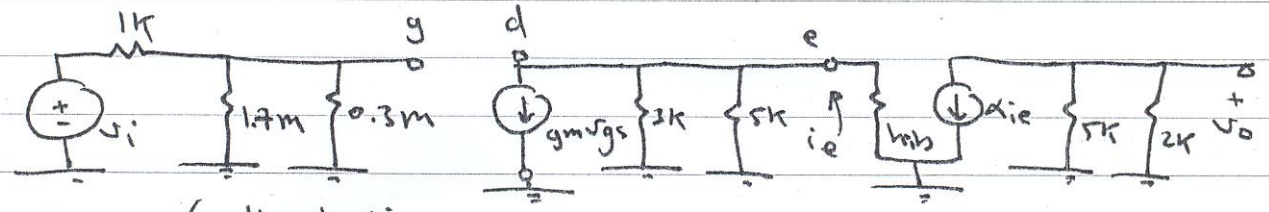
Q1: $h_{ib} = \frac{h_{ie}}{h_{fe}+1} \cong 30\,\Omega$



$v_o = -(5K \| 2K)\,\alpha i_e$

$i_e = g_m v_{gs} \cdot \frac{3K \| 5K}{3K \| 5K + h_{ib}}$; $v_{gs} = v_g - v_s = \frac{0.3M \| 1.7M}{0.3M \| 1.7M + 1K} v_i$

$\therefore A_v = -5.62$.

Q2: DC Analysis :

$V_{TH} = \frac{10K}{10K+47K} \cdot 15 = 2.6\,V$; $R_{TH} = 10K \| 47K = 8.25K$

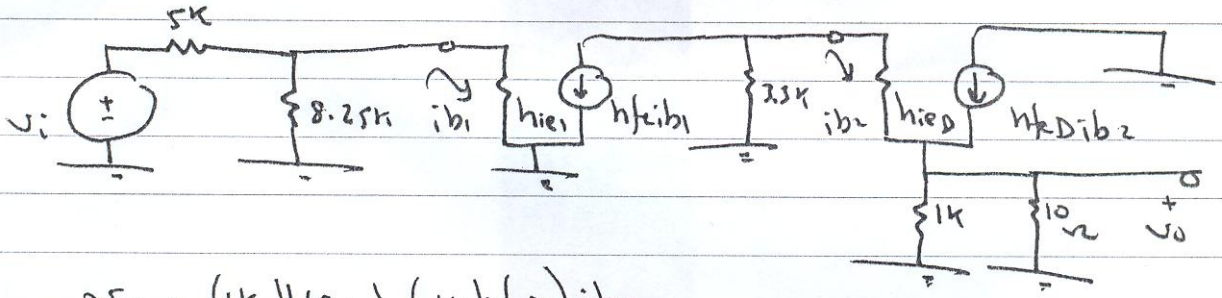
$\therefore I_{E_1} = 1.825\,mA$; $h_{ie_1} \cong 2.85K$

$V_{cc} = 3.3K(I_{C_1} + I_{B_2}) + 0.7 + 0.7 + (\beta_2+1)(\beta_1+1) I_{B_2}(1K)$

$\therefore I_{E_2} = 0.075\,mA$, $I_{E_3} = 7.575\,mA$

$h_{ie_2} = 34.67K$; $\therefore h_{ieD} \cong 70K$; $h_{feD} \cong 10000$

ac small signal analysis :



$v_o = (1K \| 10\Omega)(1 + h_{feD}) i_{b_2}$

$i_{b_2} = -h_{fe} i_{b_1} \frac{3.3K}{3.3K + (1K \| 10\Omega)(1+h_{feD})}$, $i_{b_1} = \frac{8.25K}{8.25K + h_{ie_1}} i_i$

$i_i = \frac{v_i}{5K + Z_i}$; $Z_i = 8.25K \| 2.85K \cong 2.1K$

$\therefore v_o \cong -40\, v_i \rightarrow A_v \cong -40$

(b) $v_o = -h_{fe} i_{b_1} (3.3K \| 10\Omega)$; $i_{b_1} = 0.74\, i_i$

$i_i = 0.14\, v_i$

$\therefore A_v = -0.207$.

Q3: $V_{G1} = \frac{1M}{1M+1.5M} \cdot 20 = 8V$, $V_{S1} = 4.7K\, I_{DS1}$

$$I_{DS1} = I_{DSS}\left(1 - \frac{V_{GS1}}{V_P}\right)^2 \rightarrow I_{DS} = \begin{cases} 1.92mA & \checkmark \\ 2.36mA & \times \end{cases}$$

KVL: $4.1K\, I_{DS2} + V_{GS2} - 4.7K\, I_{DS2} = 0$

$V_{GS2} = -7.9 + (4.7K)(I_{DS2})$

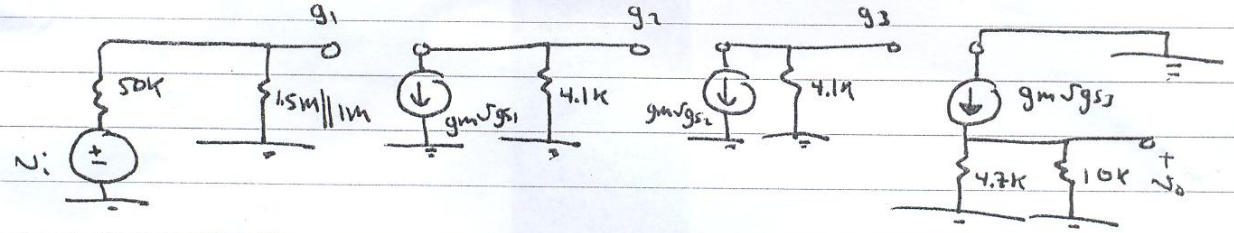
$\therefore I_{DS2} = \begin{cases} 2.33mA & \times \\ 1.89mA & \checkmark \end{cases}$

KVL: $-(4.1K)\, I_{DS2} + V_{GS3} + (4.7K)\, I_{DS3} = 0$

$\therefore V_{GS3} = 7.8 - (4.7K)(I_{DS3})$

$\therefore I_{DS3} = \begin{cases} 1.88mA & \checkmark \\ 2.3mA & \times \end{cases}$

$g_{m1} \approx g_{m2} \approx g_{m3} = 3.9m\mho$



$V_o = (4.7K \| 10K)\, g_m V_{gs3}$; $V_{gs3} = V_{g3} - V_{s3}$, $V_{s3} = V_o$

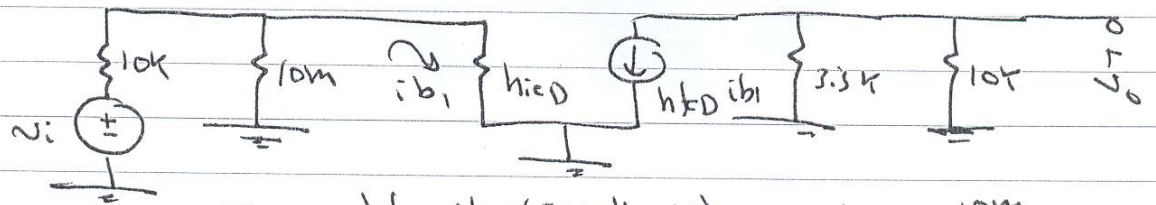
$V_{g3} = -g_m V_{gs2}(4.1K)$, $V_{s2} = 0$

$V_{g2} = -g_m V_{gs1}(4.1K)$; $V_{s1} = 0$, $V_{g1} = \frac{1.5M \| 1M}{1.5M \| 1M + 50}\, V_i$

$A_V \cong +218$

Q4 DC Analysis $5 = 10M\, I_{B1} + 1.4 \rightarrow I_{B1} = 0.36\mu A$

$h_{ie1} \cong 72K \rightarrow h_{ieD} \cong 144K$



$V_o = -h_{fD}\, i_{b1}\,(3.3K \| 10K)$; $i_{b1} = \frac{10M}{10M + h_{ieD}}\, i_i$

$i_i = \frac{V_i}{10K + Z_i}$; $Z_i = 10M \| h_{ieD}$

$\therefore A_V \cong -40$